

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
9 June 2005 (09.06.2005)

PCT

(10) International Publication Number
WO 2005/053191 A1

(51) International Patent Classification⁷: **H04B 17/00,**
H01Q 1/24, 21/28

(21) International Application Number:
PCT/GB2004/004905

(22) International Filing Date:
19 November 2004 (19.11.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0327041.0 21 November 2003 (21.11.2003) GB

(74) Agents: MACKETT, Margaret Dawn et al.; BAE
SYSTEMS plc, Group IP Department, Lancaster House,
P.O. Box 87, Farnborough Aerospace Centre, Farnborough
Hampshire GU14 6YU (GB).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

(71) Applicant (for all designated States except US): BAE
SYSTEMS PLC [GB/GB]; 6 Carlton Gardens, London
Greater London SW1Y 5AD (GB).

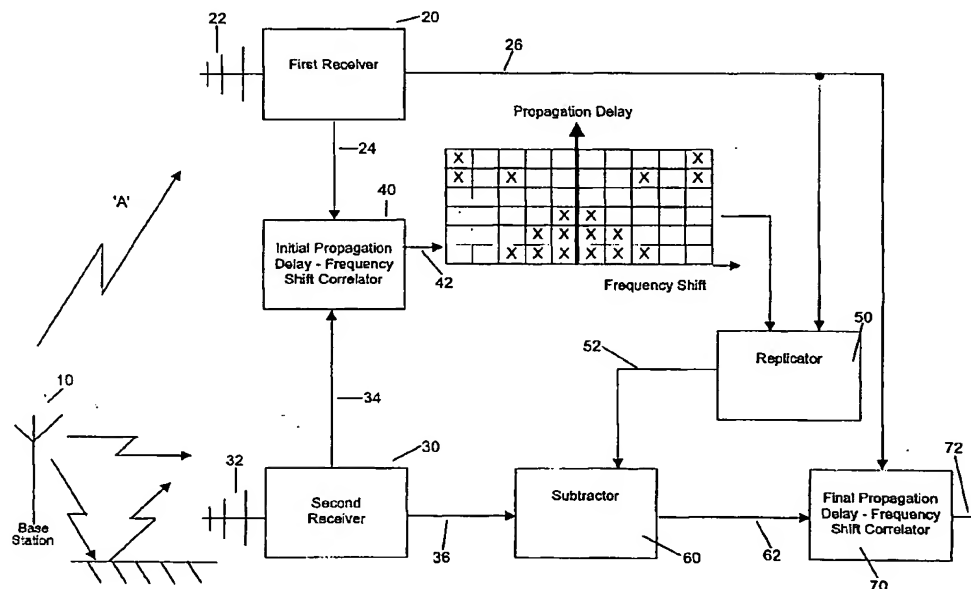
(72) Inventor; and

(75) Inventor/Applicant (for US only): RICHARDSON,
Michael, Richard [GB/GB]; 16 Knyght Close, Romsey
Hampshire SO51 5UX (GB).

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LU, MC, NL, PL, PT, RO, SE,
SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, MI, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: ENHANCING SIGNALS



(57) Abstract: Described herein is a method of enhancing signals received by a receiver in a mobile telecommunications network. The method comprises correlating the received signals to produce a correlation and making a selection from the correlation to create a replica for enhancing the received signals.



Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

- 1 -

ENHANCING SIGNALS

The present invention relates to enhancing signals in a mobile telecommunications network.

Base stations are adapted to operate in specific environments having
5 local infrastructure, for example, buildings, and other environmental factors
(including geographical features such as terrain and trees). The local
infrastructure and environmental factors are known to give rise to perturbations
in the transmission of signals. These perturbations can take the form of errors
in the received signals, and signal degradation may occur during the
10 transmission of any signals due to signal attenuation, multi-path reflection,
multi-path dispersion, background noise or as a result of cross talk from
adjacent cells. All these effects reduce the efficiency and performance of the
telecommunications cell.

In order to overcome these effects, it is useful to determine the
15 propagation characteristics of a cell within a mobile telecommunications
network so that compensation can be made for the specific environment of each
cell in the network, for example, to enhance the signal-to-noise (S/N) ratio within
that cell.

In accordance with one aspect of the present invention, there is provided
20 a method of enhancing signals in a mobile telecommunications system, the
system comprising a base station and first and second receivers within a
reception zone of the base station, the method including:

- a) receiving a plurality of first signals at the first receiver, the first
receiver having good quality communication link with the base station;
- 25 b) receiving a plurality of second signals at the second receiver;
- c) correlating the received signals from both receivers to provide an
estimated correlation therefor;
- d) selecting areas from within the estimated correlation;
- e) creating a replica of unwanted signals using said selection and
30 said plurality of first signals; and

- 2 -

f) enhancing said plurality of second signals by eliminating said replica therefrom.

Preferably, the estimated correlation comprises a correlation of propagation delay and frequency shift for the received signals.

5 Additionally, step f) includes correlating said enhanced plurality of second signals with said plurality of first signals to produce an enhanced correlation. The enhanced correlation may comprise a correlation of propagation delay and frequency shift for the enhanced plurality of second signals and the plurality of first signals.

10 For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings, in which:

Figure 1 illustrates a block diagram of a system for determining propagation characteristics in accordance with the present invention;

15 Figure 2 illustrates an enlarged view of the output of the correlator shown in Figure 1; and

Figure 3 is similar to Figure 2 but with the selection enhanced.

The present invention relies on correlation being made in both time and frequency domains between a plurality of signals received at a first and a second receiver from the same base station. These signals can be referred to
20 as first receiver signals and second receiver signals. As both receiver signals tend to have good auto-correlation properties, that is, having a large main peak at zero relative delay and low side lobes elsewhere (not shown), it is possible to resolve components of the received signals in terms of their amplitudes, time delays, frequency shifts and phase shifts with respect to the first receiver signal.
25 It is therefore possible to categorise unwanted signals in terms of relative time delay (propagation delay) and frequency shift. The signal components that fall into the unwanted category can be identified by their propagation delay and frequency shift characteristics, and good estimates with respect to the first receiver signal can be obtained. These estimates are then used in conjunction
30 with the first receiver signal to create replica signals of the signals

- 3 -

corresponding thereto. The replica signals are then subtracted from the second receiver signals to remove the unwanted signals. This has the effect of substantially reducing the unwanted signals so that a final correlation with the first receiver signal enhances the detection of the required signals.

5 Referring now to Figure 1, a base station 10 located in a cell (not shown) is shown together with a first receiver 20 and a second receiver 30. The first receiver 20 is positioned in the cell to have a direct line-of-sight with the base station 10 as indicated by arrow 'A'. Whilst it is necessary for the first receiver 20 to have a good quality communication link with the base station 10, this is
10 not the case for the second receiver 30. Each receiver 20, 30 has a respective antenna 22, 32 for receiving signals from the base station 10. The good quality communication link can be achieved by using an elevated receiver, an antenna with direct gain, a line-of-sight propagation path, advanced signal processing techniques, other suitable methods, or combinations thereof.

15 Each receiver 20, 30 is connected to a correlator 40 to correlate received signals 24, 34 therefrom. Output 42 from correlator 40 can be displayed as a plot of propagation delay against frequency shift for the received signals. An enlarged view of output 42 is shown in Figure 2.

For illustrative purposes, crosses placed on the plot indicate signals that
20 have been received and classified in terms of propagation delay, frequency shift, amplitude and phase relative to the first receiver signal.

A second output 26 from the first receiver 20, identical to output 24, is provided to a replicator 50 together with output 42. The replicator 50 creates a replica signal 52 based on a selection 44 (Figure 2) made from the output 42.
25 The replica signal 52 forms one input to a subtractor 60. The other input to the subtractor 60 is a second output 36 from the second receiver 30.

In the subtractor 60, the replica signal 52 is subtracted from the signals received at the second receiver 30 to provide subtracted output signal 62. Output signal 62 forms one of the inputs to a second correlator 70, the second
30 output 26 from the first receiver 20 forming the second input.

- 4 -

Correlator 70 is identical to correlator 40 and correlates signals from the first receiver 20, output 26, and the subtracted output signal 62 from the second receiver 30 to provide output 72. Output 72 can be displayed in a similar way to output 42 but, as shown in Figure 3, only selection 74 corresponding to selection 44 of Figure 2 is enhanced. As a result, the selection 44 is enhanced.

Naturally, the output obtained can be tailored by the selection 44 (Figure 2) and any other portion of the output 42 can be selected and used as the basis for the replica signal 52.

In Figure 2, the output 42 is shown in more detail. Here, a number of signals 80 are present in the propagation delay/frequency shift domain. In this case, however, only signals 80' within selection 44 are of interest. Signals 80" are to be removed in the subsequent processing - these signals forming the basis of the replica signal 52. It will be appreciated that signals 80" may detract from the performance of the system.

In Figure 3, only signals 80' remain after correlation of the output 62 and second output 26 from the first receiver 20 (Figure 1).

It will be appreciated that the conceptual correlation processes in the time delay and frequency shift domains may be conveniently implemented in either the time or frequency signal processing domains, for example, by employing Fast Fourier Transform (FFT) processing as is well understood by those skilled in the art.

It will also be appreciated that the time delay correlation resolution is dependent on fundamental physical laws relating to the bandwidth and modulation characteristics of the signal in use and other factors such as system noise levels. The frequency resolution will essentially depend on the integration period applied during the received signal processing and other factors such as system noise levels. In additions, it will be appreciated that other resolution limits may be imposed in practice by such factors as the period over which the overall propagation and environmental conditions remain stable.

- 5 -

CLAIMS

1. A method of enhancing signals in a mobile telecommunications system, the system comprising a base station and first and second receivers within a reception zone of the base station, the method including:
 - 5 a) receiving a plurality of first signals at the first receiver, the first receiver having a good quality communications link with the base station;
 - b) receiving a plurality of second signals at the second receiver;
 - c) correlating the received signals from both receivers to provide an estimated correlation therefor;
 - 10 d) selecting areas from within the estimated correlation;
 - e) creating a replica of unwanted signals using said selection and said plurality of first signals; and
 - f) enhancing said plurality of second signals by eliminating said replica therefrom.
- 15 2. A method according to claim 1, wherein the estimated correlation comprises a correlation of propagation delay and frequency shift for the received signals.
3. A method according to claim 1 or 2, wherein step f) includes correlating said enhanced plurality of second signals with said plurality of first signals
20 to produce an enhanced correlation.
4. A method according to claim 3, wherein the enhanced correlation comprises a correlation of propagation delay and frequency shift for the enhanced plurality of second signals and the plurality of first signals.

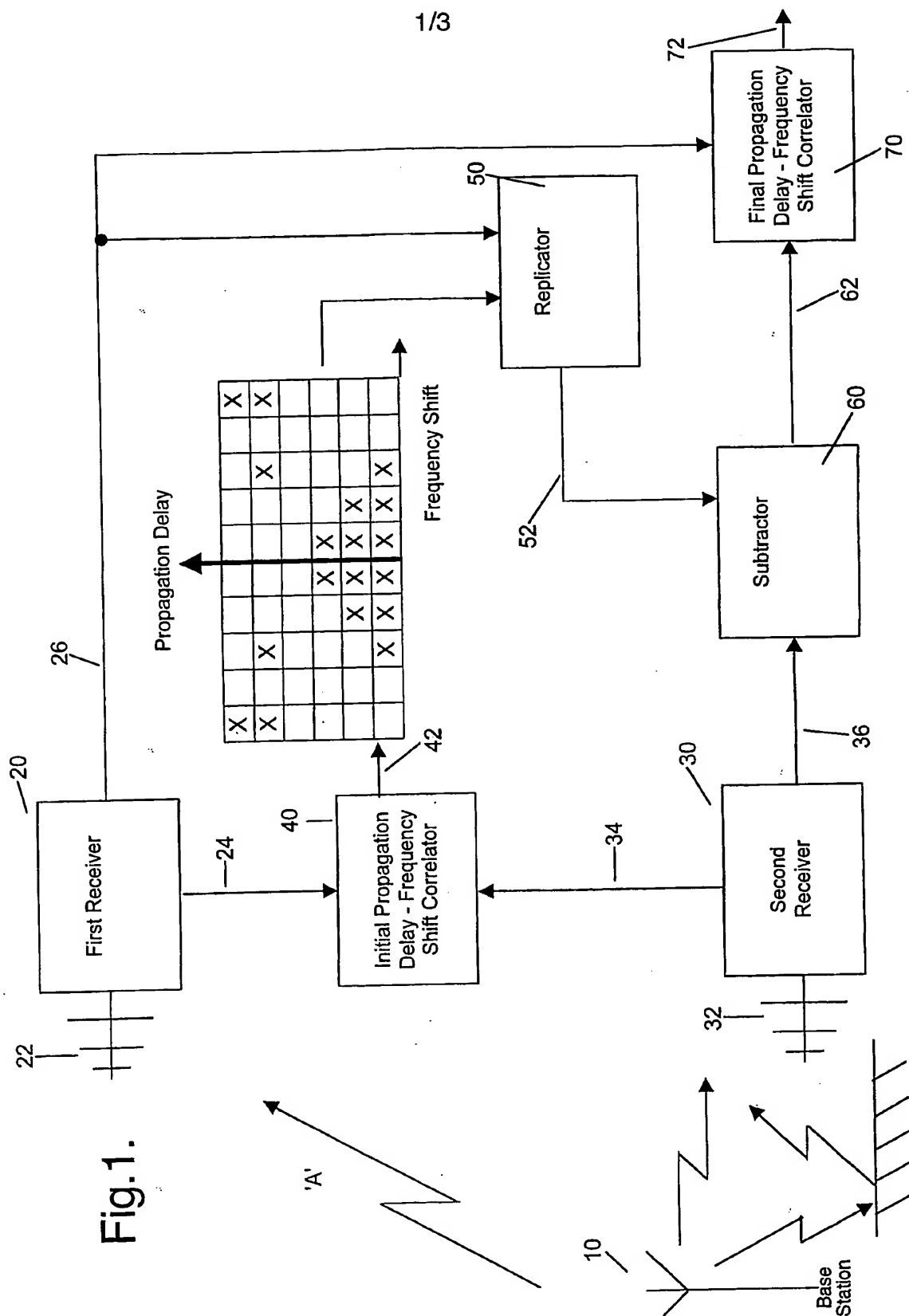
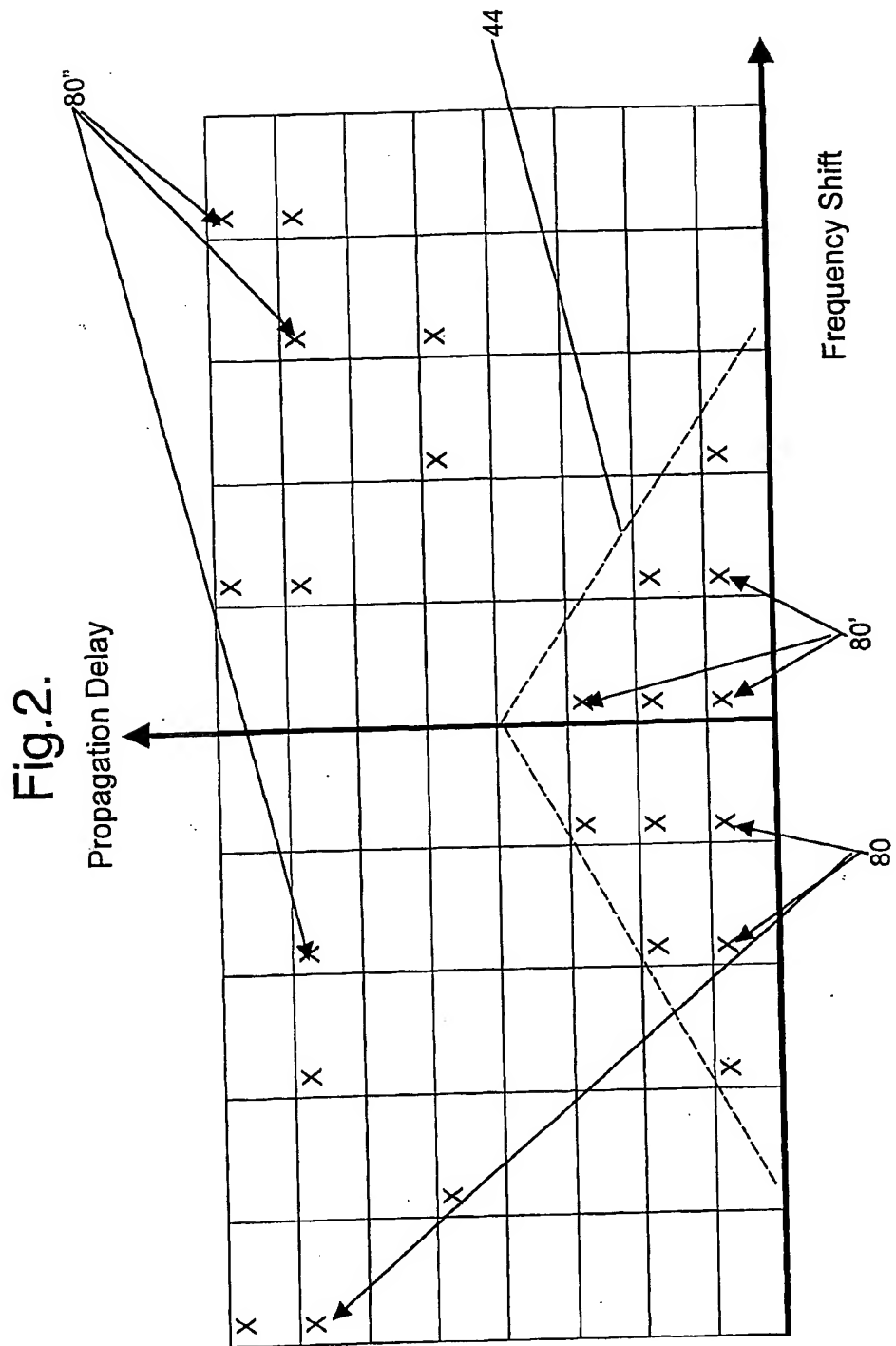
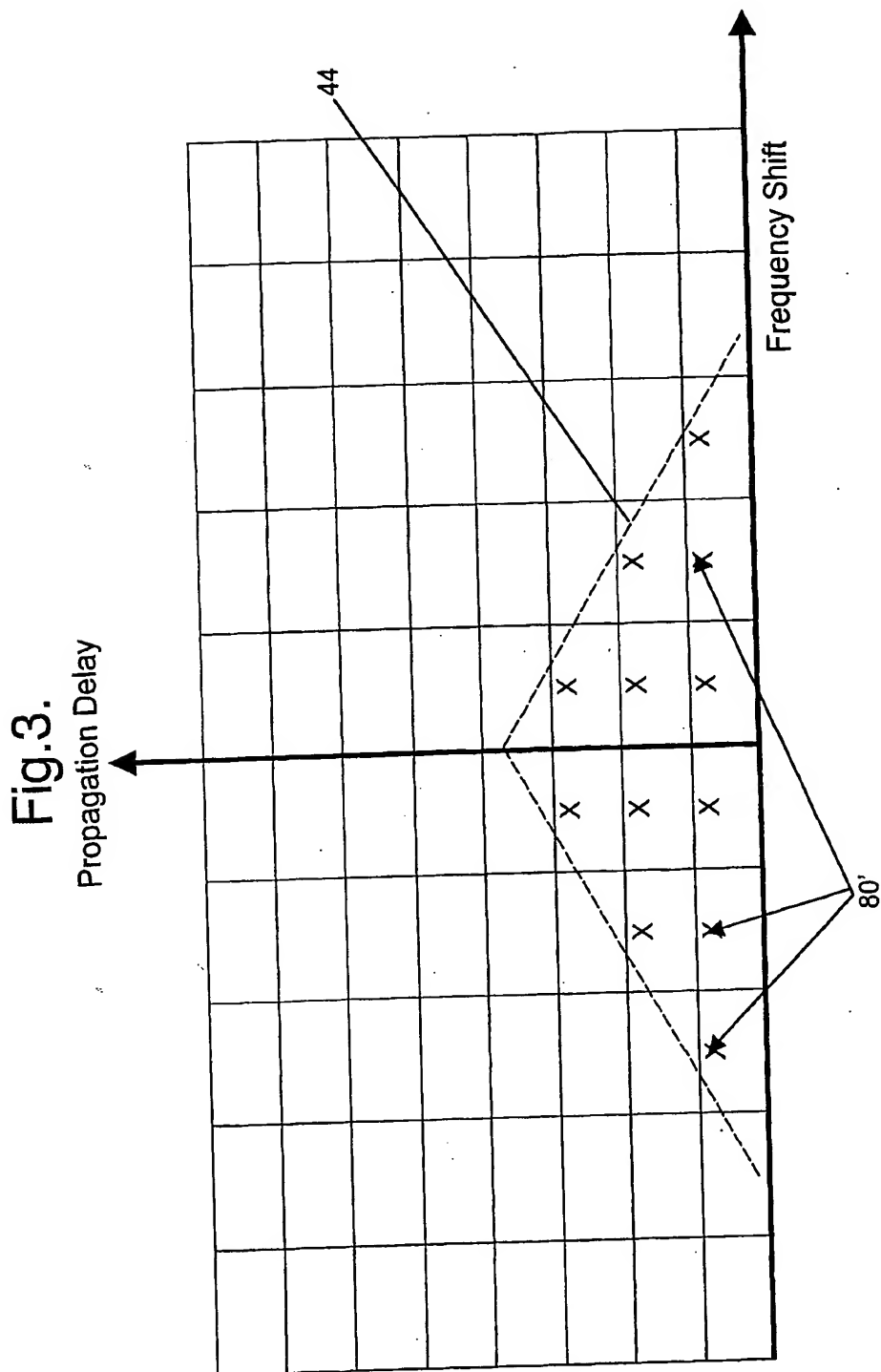


Fig. 1.





A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04B17/00 H04Q7/36 H01Q1/24 H01Q21/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04B H04Q H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 088 383 A (SUZUKI ET AL) 11 July 2000 (2000-07-11) abstract column 2, line 45 - line 55 column 5, line 55 - column 6, line 14 figure 1	1-4
A	US 5 675 581 A (SOLIMAN ET AL) 7 October 1997 (1997-10-07) column 3, line 1 - column 4, line 30	1-4

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

18 February 2005

Date of mailing of the international search report

25/02/2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Lustrini; D

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB2004/004905

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6088383	A	11-07-2000	JP 3272940 B2	08-04-2002
			JP 11234167 A	27-08-1999
			WO 9733401 A1	12-09-1997
			SE 522286 C2	27-01-2004
			SE 9704026 A	07-01-1998
			JP 3314199 B2	12-08-2002
<hr/>				
US 5675581	A	07-10-1997	AT 206575 T	15-10-2001
			AU 688090 B2	05-03-1998
			AU 3129195 A	16-02-1996
			BR 9506283 A	12-08-1997
			CA 2170636 A1	01-02-1996
			CN 1404239 A	19-03-2003
			CN 1130450 A ,C	04-09-1996
			DE 69523030 D1	08-11-2001
			DE 69523030 T2	27-06-2002
			EP 0719481 A1	03-07-1996
			FI 961150 A	10-05-1996
			HK 1015195 A1	24-05-2002
			JP 3078328 B2	21-08-2000
			JP 9503118 T	25-03-1997
			RU 2138124 C1	20-09-1999
			WO 9602986 A1	01-02-1996
			ZA 9505605 A	10-04-1996
<hr/>				